Maggot debridement therapy in surgery

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Chapter

4

Considerations in application technique

Based on the following article:

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Introduction

There are two different application techniques for MDT: the free-range technique and the contained technique. There is a debate on which method should be used. This retrospective study describes clinical observations in 64 patients, in order to see which technique is most effective.

Free-range technique

In his work, Baer[13] used a free-range technique in which the maggots were put freely in the wound. A "cage" was then placed around the wound, preventing the maggots from escaping. Sherman[99-101] describes the most widely applied free-range technique used today: Disinfected maggots are applied to the wound surface area, the wound and maggots are covered with a cagelike dressing, and the dressing is topped with nylon chiffon.

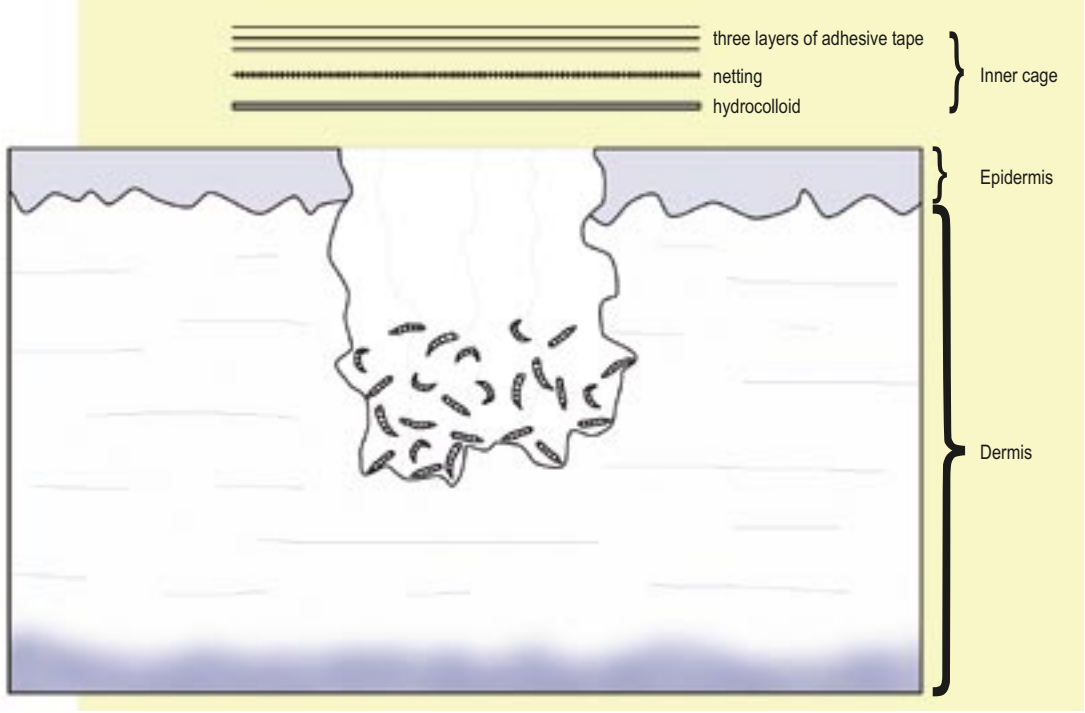

Figure 1: Free-range technique: Maggots are placed freely in the wound. To prevent escape, maggots are covered by an "inner cage."

Contained Technique

Because maggots in the contained technique are placed in the wound in a bag, maggot migration (or escape from the wound) occurs less frequently[102], which is essential for hospital hygiene.[103] Containment, however, can have a significantly negative effect on maggot growth.[104] Although physicians prefer the free-range technique, it is generally believed that patients would be more agreeable to MDT if the contained technique is used.[105] Maggots are not visible with the contained technique, which seems to improve patient acceptance. In a phenomenological study, Kitching[106] showed that the experience of MDT was not as scary as patients had imagined. Steenvoorde et al[107] reported that when patients were well informed, few were deterred by the idea of maggots, and there was a high degree of acceptance of MDT therapy with either application technique.

In addition, a recently introduced contained MDT technique[103] (Biobag; BiologiQ, Apeldoorn, The Netherlands) improves the acceptance of live maggots, facilitates their use,[108] and avoids physical discomfort.

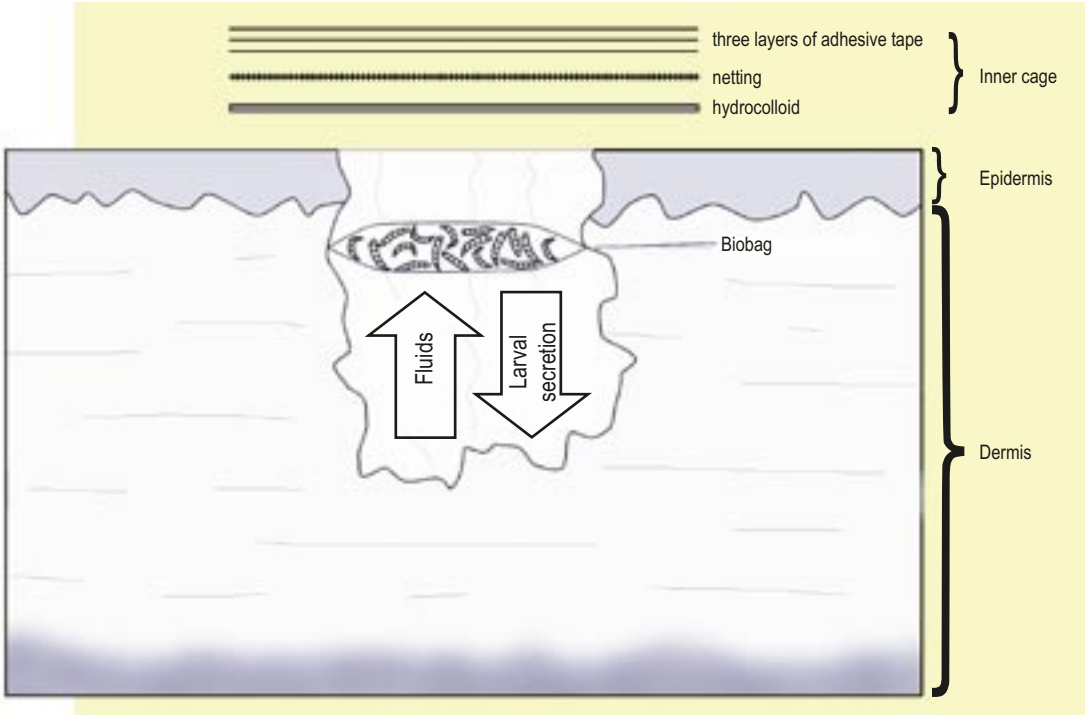

Figure 2: Contained Technique: In the contained technique, the maggots are placed in a bag (either self-fabricated or commercially available).

Methods

Between August 2002 and December 2004, 64 patients were enrolled in a study comparing free-range and contained techniques of MDT; all patients gave informed consent. These patients had presented at the Rijnland Hospital surgical department with 69 chronic wounds that showed signs of gangrenous or necrotic tissue. For this study, chronic wounds were arbitrarily defined as wounds existing for longer than 4 weeks.

In general, a chronic wound is defined as any wound that fails to heal within a reasonable period; there is no clear cutoff point for wound chronicity.[109] Patients were not eligible for the study if the treating surgeon believed an urgent amputation could not be postponed (eg, because of severe sepsis) or if life expectancy was less than a few weeks.

The 3 physicians and 3 nurses involved in the study recorded the following patient characteristics: age, sex, treatment location, and American Society of Anesthesiologists (ASA) classification, which is a physical status classification that serves as a prediction of anesthetic/surgical risks **(Table 1)**. In addition, they recorded the following wound characteristics: duration (in weeks), location (eg, toe, foot, heel, lower leg, below-knee amputation, or other), size (measuring the largest diameter), and depth (superficial, containing only epidermal and dermal layers, and deep, containing bone, joint, or tendon).

Table 1: Anesthesia/surgical risk classification*

Class I	—	healthy patient
Class II	—	patient with mild systemic disease
Class III	—	patient with severe systemic disease
Class IV	—	patient with severe systemic disease that is a constant threat to life
Class V	—	moribund patient; not expected to live longer than 24 hours, irrespective of surgery

* Based on guidelines from the American Society of Anesthesiologists.

Maggot debridement therapy

Because they were not commercially available at the start of the study, maggots were obtained from the nearest university medical center. Maggot application was done on Tuesday and Friday afternoons. Each MDT application remained on the wound for 3 to 4 days; MDT continued until thorough debridement was achieved. At the authors' institution, MDT was introduced with the contained technique, and the first 6 of 69 study wounds (9%) were treated this way. Since then, the standard application technique at the institution has been the free-range technique. However, there were no strict indications for either technique. The choice of application technique was determined by maggot availability, wound dressing difficulty, and physician preference. The following therapy characteristics were recorded: number of maggots needed, number of applications, type of application technique, and whether the patient was admitted to the hospital during MDT. With the free-range technique, maggots were placed freely on the wound **(Figure 1)**.[101] First, a hydrocolloid sheet (DuoDerm Thin; ConvaTec, Skillman, NJ) was taped to the skin surrounding the wound. Nylon netting (BiologiQ) was then taped on the wound edges. The purpose of the adhesive and the covering net (inner cage) was to act as a barrier to reduce maggot migration. The outer cage, consisting of wet gauze and a light bandage, was then wrapped over the net. Because maggots may not thrive if the wound is too dry, the outer cage was changed daily as needed. Laboratory results indicate that diluting maggot excretions with normal saline (0.9% sodium chloride) does not influence the effect of therapy; however, dilution with sterile distilled water causes a considerable drop in bacterial action.[110] Therefore, normal saline was used to wet the gauze in the present study. For the contained technique, maggots were placed in either a polyvinyl alcohol (PVA) or a net bag **(Figure 2)**. With the PVA bag, the maggots were enclosed between

2 thin (0.5 mm) layers of PVA hydrosponge, which were heat-sealed over a small cube of spacer material to form a bag.[103] These bags were either selffabricated or purchased commercially (Biobag). With the net bag, the maggots were placed in nylon netting with a small cube of spacer material; the netting was closed with a suture. The bag containing the maggots was then placed inside the wound. Similar to the free-range technique, nylon net was placed over the bag and taped on the wound edges. Wet gauze and a light bandage were then wrapped over the net. It is debatable, however, if an outer cage is necessary with the contained technique. A simpler application technique is to place the bag in the wound and cover it only with the wet gauze and a light bandage. The number of maggots per bag varied. The self-fabricated PVA bags contained 15 to 20 maggots,[102] commercially available PVA bags contained 100 to 200 maggots, and self-fabricated nylon netting bags contained 50 to 200 maggots.

Eight MDT outcomes were defined according to outcome definitions reported in the literature[55;88-90;93] and the authors' experience with the technique. These include (1) wound fully closed by secondary intervention (eg, split-skin graft), (2) wound fully closed spontaneously, (3) wound free from infection and less than one third the initial size, (4) wound clean (free from infection/ necrosis/slough, but same as initial size), (5) no difference, (6) wound worsened, (7) minor amputation (eg, partial toe amputation), and (8) major amputation (eg, below-knee amputation). Outcomes 1 through 4 were considered beneficial MDT outcomes; outcomes 5 through 8 were considered unsuccessful MDT outcomes. However, because it is difficult to define meaningful outcomes of MDT, and even more difficult to compare MDT results with other studies, the outcomes in the present study were not defined as wound scores.[111] Instead, outcomes were based on an intention to salvage limbs. Church and Courtenay[88] have suggested the following outcomes for MDT: complete, temporarily complete, relatively complete, significantly beneficial, partially beneficial, economical, and failed. These categories are somewhat misleading, however. For example, a patient who dies before complete wound healing would be included in the "failed" category. In the present study, however, the same patient would be placed in outcome category 3.

Descriptive analysis techniques (chi-square and t test) were used to describe the results of MDT using free-range and contained techniques (SPSS 11.5 for Windows; SPSS, Inc, Chicago, IL). Differences were found to be statistically significant if P values were below .05.

Results

Most patients were treated as outpatients, with 25 patients (39.1%) admitted to the hospital. The study included 37 men (57.8%) and 27 women (42.2%), with an average patient age of 68.5 years (SD 15.2). At presentation, most patients were in ASA categories III and IV (n = 39; 60.9%), indicating high anesthetic/surgical risk. Thirty-two patients were diabetic (50%), and 34 patients (53%) met the criteria of chronic limb ischemia. The Second European Consensus[74] criteria for diagnosing chronic limb ischemia are recalcitrant rest pain or distal necrosis of more than 2 weeks' duration in the presence of a systolic ankle pressure of 50 mm Hg or less. These data were not recorded for patients with wounds above the ankle. Of the 69 wounds, 54 (78%) were treated with free-range MDT and 15 (22%) were treated with the contained technique. In the contained technique group, 6 patients received the selffabricated PVA bag,[102] 6 patients received the commercially available PVA bag, and 3 patients received the self-fabricated net bag. Seventeen (25%) wounds were traumatic in origin, and most wounds had existed for more than 3 months before therapy (n = 43; 62%). Wounds were located on the toe

(n = 6), feet (n = 16), heel (n = 18), lower leg (n = 21), or other location (n = 8). Thirty-five wounds (51%) were considered superficial, and 34 (49%) were deep. There were no statistical differences in patient and wound characteristics between the 2 application techniques.

Average number of treatments/maggots

The mean number of maggot applications was 2.8 (range 1-11), indicating an average treatment of 9 days. Of wounds with successful outcomes (n = 50), 15 (30%) needed only a single application of maggots. Another 29 wounds (58%) were fully debrided within 1 week (ie, 1 or 2 maggot applications needed). Overall, about 12,580 maggots were used for 69 wounds, indicating an average of 182 maggots per wound (range 20-500). On average, the contained technique required more maggot applications than the free-range technique (4.3 vs. 2.4 treatments; P = .028) and more maggots to complete the treatment per wound (277 vs. 156 maggots; P < .001) **(Table 3)**. No statistical differences were seen between the techniques regarding the average number of maggots used per application (83 vs. 68 maggots; P = .101). Because more maggot applications were needed with the contained technique than with the free-range technique, the contained technique was also more costly. In addition, commercially contained maggots are more expensive.

Outcomes

Of 69 wounds, 50 (73%) had beneficial outcomes and 19 (27%) had unsuccessful outcomes **(Table 4)**. In 41 cases, the wound fully closed spontaneously or by secondary intervention. Minor amputation occurred in 4 cases (6%), with major amputation in 12 cases (17%). In the contained technique group, 6 of 15 patients eventually needed major amputation, compared with only 6 of 54 patients in the free-range technique group (P < .01). Free-range-treated wounds had more beneficial outcomes than wounds treated with the contained technique (n = 43 [79.6%] vs. n = 7 [46.7%]; P = .028).

Discussion

It is not completely clear why MDT promotes wound healing. Healing may be related to mechanical effects[112] or tissue growth effects[49]; it may be a result of the direct killing of bacteria in the alimentary tract of the maggots[83-85]; or it may be a result of antibacterial factors produced by maggots.[113] Some of these mechanisms seem to work less efficiently with the contained technique of MDT. However, the contained maggots still produce some activity, which supports the "soup" theory of Thomas et al.[48] This theory states that necrosis, wound exudate, and the various substances produced by maggots form a soup, which the maggots then further ingest.

Maggot containment may reduce effectiveness,[104] although in-vivo research has been lacking until now. In the present study, the free-range technique resulted in significantly better outcomes compared with the contained technique (P = .028). The mean number of treatments was also lower with the free-range technique than with the contained technique (P = .028). No differences in wound depth or size were found between the groups. The number of maggots used per treatment was significantly lower in the free-range technique (about 160 maggots) than in the contained technique (about 280 maggots) (P < .001). Caution should be used in interpreting these study results, however; the unequal number of wounds in the groups (free-range 54, contained 15) may have had an impact. Although the contained technique of MDT appears to be less effective than the free-range technique based on the present study, it has its place in wound care.

Patient preference,[114] bleeding complications in patients with natural or pharmacologically induced coagulopathies or exposed vessels or internal organs,[101;115] and fears about hospital hygiene[102] are indications for the contained technique. Additional studies are needed to justify these different indications, however.

Conclusion

Based on clinical observation of 64 patients and earlier published studies, this nonrandomized in vivo study suggests that the contained technique reduces the effectiveness of MDT.

Table 2: Patient and wound characteristics of 64 patients with 69 wounds, treated with MDT.

		Total	Free-range	Contained	P-value
Patient characteristics		64 (100.0)	50 (78.1)	14 (21.9)	
Age	Mean (SD)	68.5 (15.2)	67.8 (15.4)	71.2 (14.8)	P=0.459
	< 60 years, N (%)	15 (23.4)	12 (24.0)	3 (21.4)	P=0.841
	≥ 60 years, N (%)	49 (76.6)	38 (76.0)	11 (78.6)	
Sex	Male, N (%)	37 (57.8)	28 (56.0)	9 (64.3)	P=0.579
	Female, N (%)	27 (42.2)	22 (44.0)	5 (35.7)	
ASA-classification	I or II	25 (39.1)	21 (42.0)	4 (28.6)	P=0.548
	III or IV	39 (60.9)	29 (58.0)	10 (71.4)	
Treatment location	Clinic	25 (39.1)	18 (36.0)	7 (50.0)	P=0.523
	Outpatient clinic	39 (60,9)	32 (64.0)	7 (50.0)	
Wound characteristics		69 (100.0)	54 (78.3)	15 (21.7)	
Size	< 2 cm	20 (29.0)	17 (31.5)	3 (20.0)	P=0.585
	≥ 2 cm	49 (71.0)	37 (68.5)	12 (80.0)	
Depth	Superficial, N (%)	35 (50.7)	29 (53.7)	6 (40.0)	P=0.517
	Deep*, N (%)	34 (49.3)	25 (46.7)	9 (60.0)	
Duration (months)	Mean (SD)	8.3 (19.3)	9.1 (21.6)	5.4 (3.6)	P=0.509
	less than 3, N (%)	26 (37.7)	23 (42.6)	3 (20.0)	P=0.195
	3 and more, N (%)	43 (62.3)	31 (57.4)	12 (80.0)	

Deep*: visible tendon, bone or muscle

Table 3: Technical characteristics of MDT in 64 patients with 69 wounds.

Therapy characteristics		Total	Free-range	Contained	P-value
		69 (100.0)	54 (78.3)	15 (21.7)	
Nr. of applications	Mean (range)	2.8 (1-11)	2.4 (1-6)	4.3 (1-11)	P=0.028
Maggots per treatment	Mean (range)	182 (20-500)	156 (20-500)	277 (100-500)	P<0.001
Maggots per application	Mean (range)	71 (15-200)	68 (15-125)	83 (30-200)	P=0.101

Table 4: Results of MDT in 64 patients with 69 wounds, separated by application technique.

Outcome	Total	Free-range	Contained	P-value
	N (%)	N (%)	N (%)	
1. Wound fully closed by second intervention	21 (30.4)	18 (33.3)	3 (20.0)	P=0.075
2. Wound spontaneous fully closed	20 (29.0)	18 (33.3)	2 (13.3)	
3. Wound free from infection and <1/3 of initial size	7 (10.1)	5 (9.3)	2 (13.3)	
4. Clean wound, but same as initial size	2 (2.9)	2 (3.7)	0 (0.0)	
5. No difference	2 (2.9)	2 (3.7)	0 (0.0)	
6. The wound is worse	1 (1.4)	0 (0.0)	1 (6.7)	
7. Minor amputation	4 (5.8)	3 (5.6)	1 (6.7)	
8. Major amputation	12 (17.4)	6 (11.1)	6 (40.0)	
Total beneficial outcome (outcomes 1-4)	50 (72.5)	43 (79.6)	7 (46.7)	P=0.028
Total unsuccessful outcome (outcomes 5-8)	19 (27.5)	11 (20.4)	8 (53.3)	
Total	**69 (100.0)**	**54 (78.3)**	**15 (21.7)**	